(12) UK Patent Application (19) GB (11) 2 335 248 (13) A

(43) Date of A Publication 15.09.1999

(21) Application No 9905276.3

(22) Date of Filing 08.03.1999

(30) Priority Data
(31) 9804756.6 (32) 07.03.1998 (33) GB

(71) Applicant(s)
CRP Group Limited
(Incorporated in the United Kingdom)
Stanley Way, Stanley, SKELMERSDALE, Lancashire, WN8 8EA, United Kingdom

(72) Inventor(s)
David Gordon Lace
Anthony Yeldrem

(74) Agent and/or Address for Service
W P Thompson & Co
Coopers Building, Church Street, LIVERPOOL, L1 3AB, United Kingdom

(51) INT CL[6]
F16L 58/02, E02D 5/60, E21B 17/01, F15D 1/10, F16L 1/12 57/00 58/10

(52) UK CL (Edition Q)
F2P PC10 PC14 P1A10 P1A12 P1A20B P1A28B P1A5 P1B7E
E1F FAC FAC1
E1H HGG
F2R RD
H2C CCL
U1S S1884

(56) Documents Cited
GB 2315797 A GB 2303898 A GB 2298016 A
GB 1279599 A GB 1019885 A WO 98/19018 A1

(58) Field of Search
UK CL (Edition Q) E1F FAC1, E1H HCE HCF HGG, F2P PC1 PC10 PC14 PC3 PC9, F2R RD RR
INT CL[6] E02D 5/60 5/64, E21B 17/00 17/01, F15D 1/00 1/10 1/12, F16L 57/00 58/00 58/02 58/10
ONLINE: WPI

(54) Abstract Title
Vortex shedding claddings for submerged tubulars

(57) Cladding 12 for an underwater pipe, cable or similar structure comprises at least one external projection to interrupt or reduce vortex induced vibrations. Preferably, the cladding has a series of helical strakes 24 on its exterior surface, the pitch of each strake preferably being approximately five times the diameter of the pipe etc to be clad. The cladding may be in the form of a series of preformed part-tubular sections 12' which are assembled to form a continuous ducting, or may comprise a series of mats (40, figure 7; 54, figure 9) which are wrapped around the pipe etc. These mats may take the form of a rectangle (figure 7) or a parallelogram (figure 9). The strakes may be resiliently compressible to allow a clad pipe to pass through pipe-laying apparatus and to allow a clad pipe to be gripped tightly if desired. The strakes may be solid, but are most preferably hollow. Slots (26, figure 3) are preferably provided in the strakes to accommodate band clamps 28 to secure the cladding to the pipe etc.

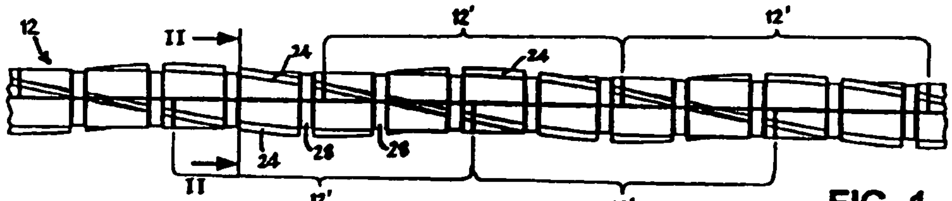

FIG. 1.

GB 2 335 248 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

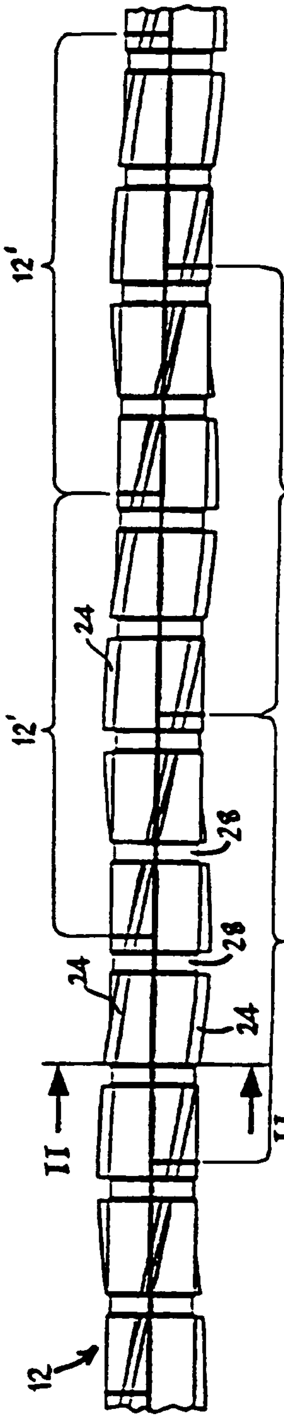

FIG. 1.

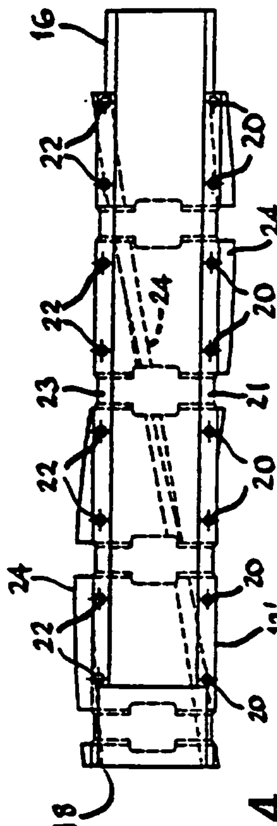

FIG. 4.

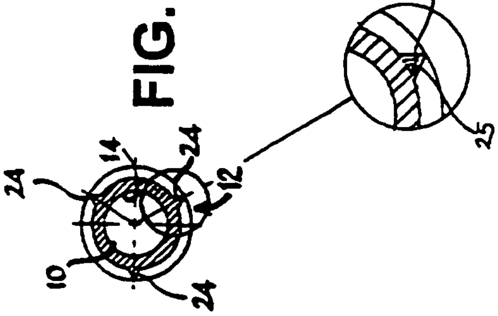

FIG. 2.

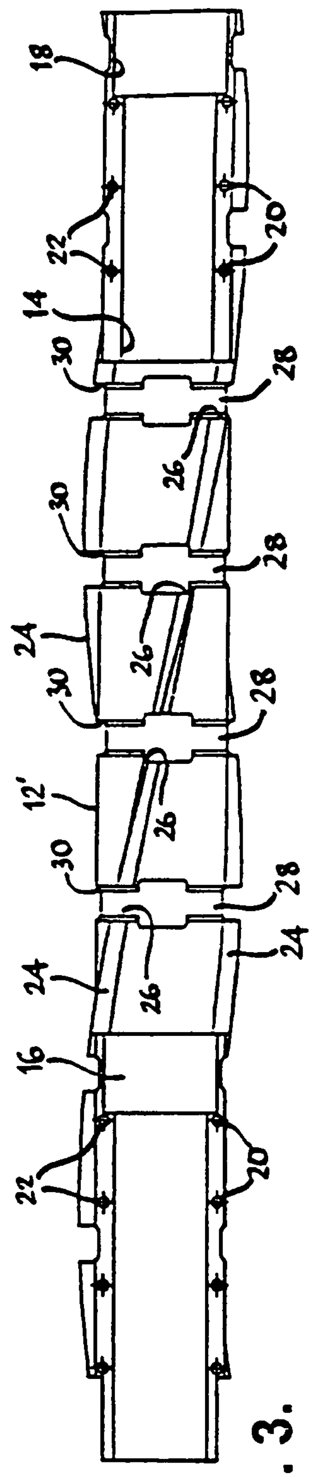

FIG. 3.

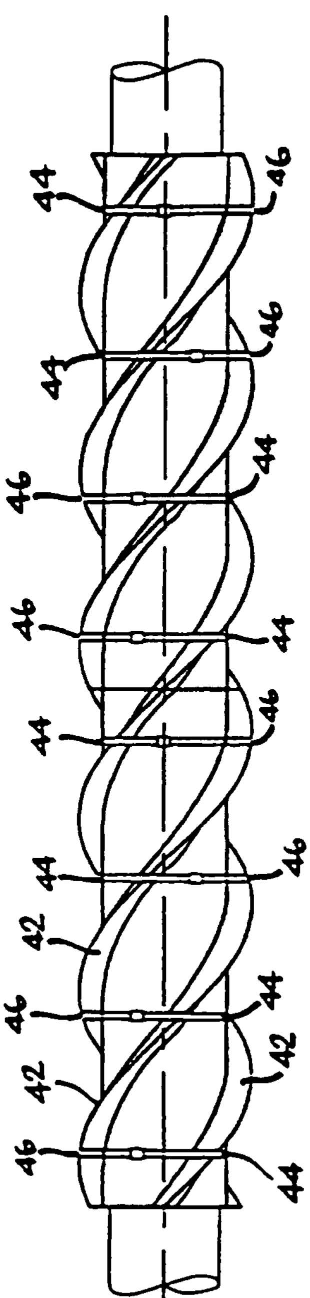

FIG. 5.

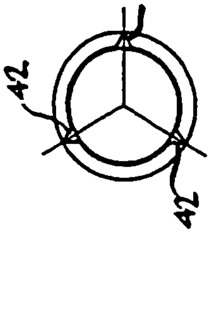

FIG. 6.

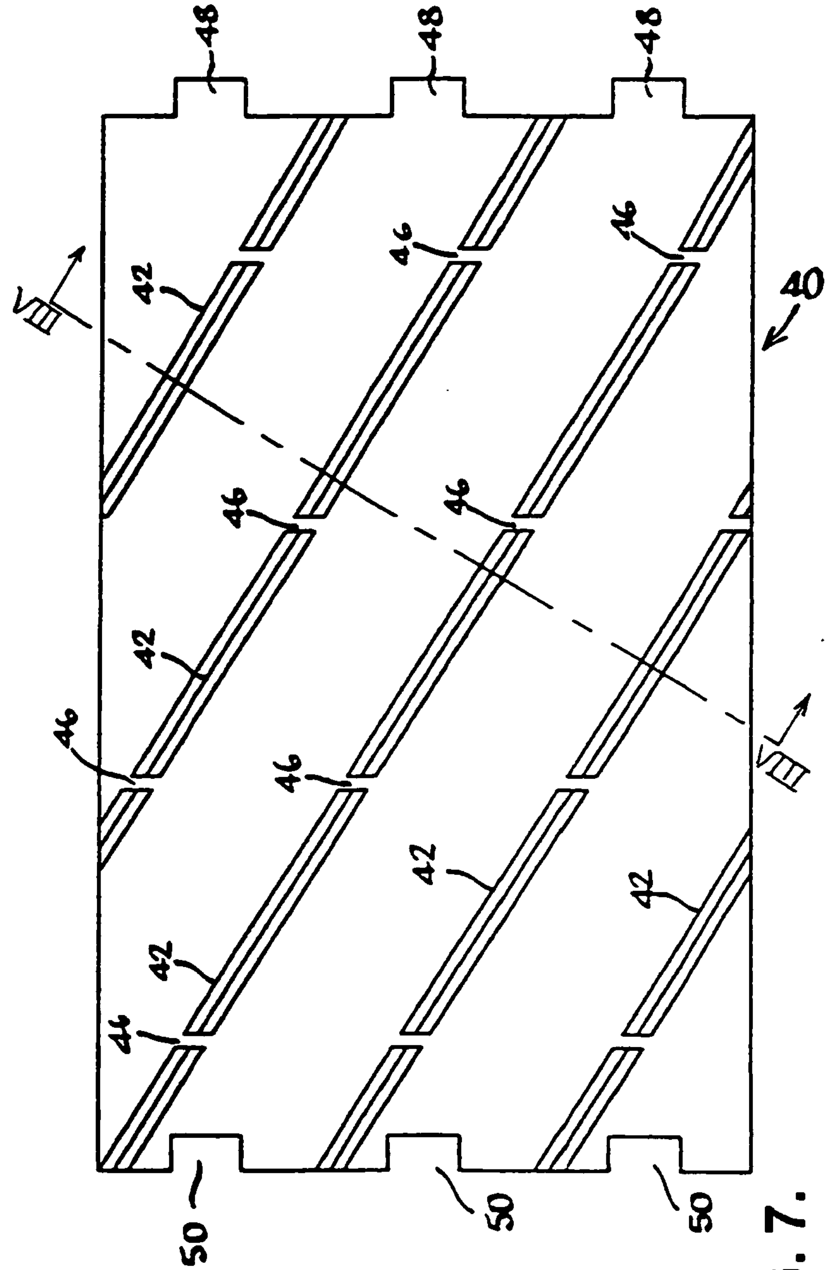

FIG. 7.

FIG. 8.

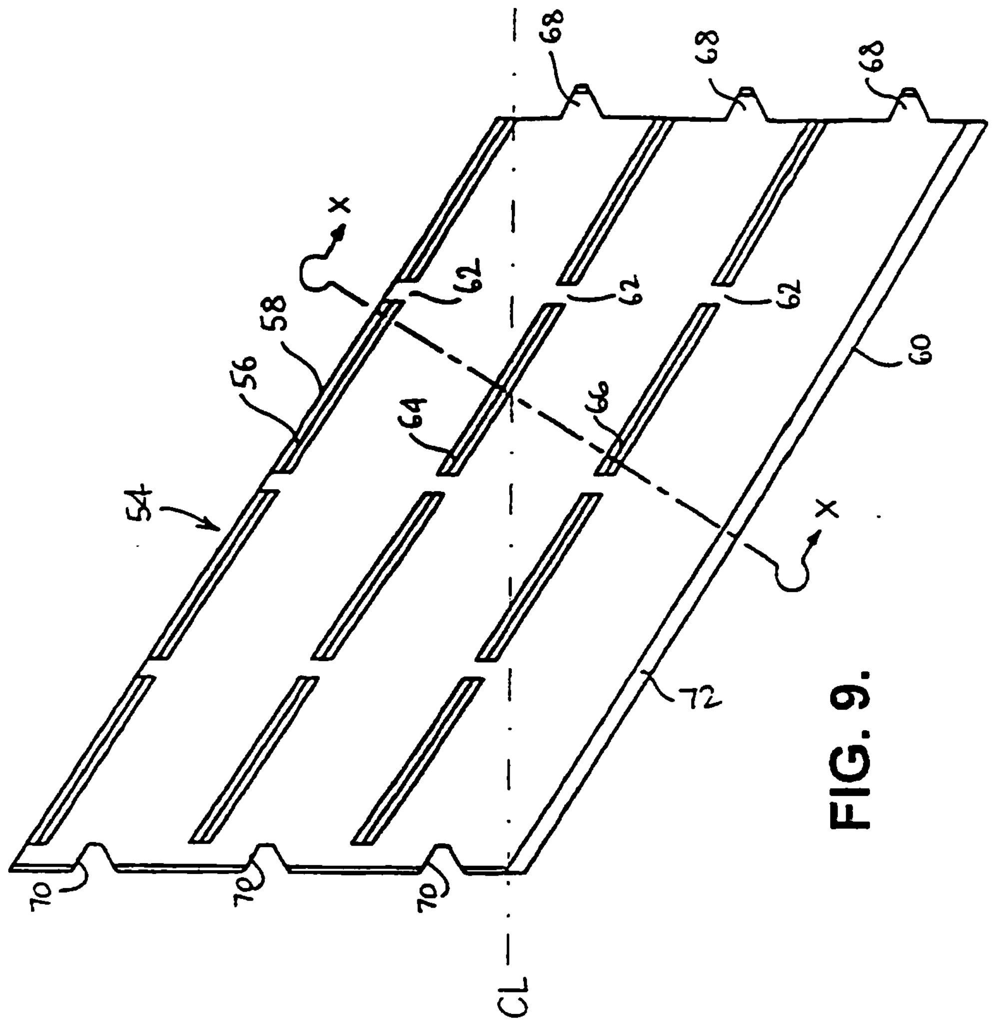

FIG. 9.

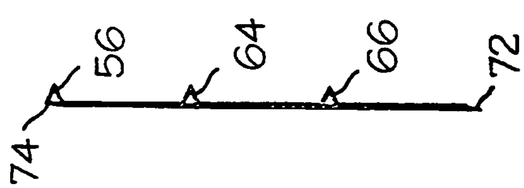

FIG. 10.

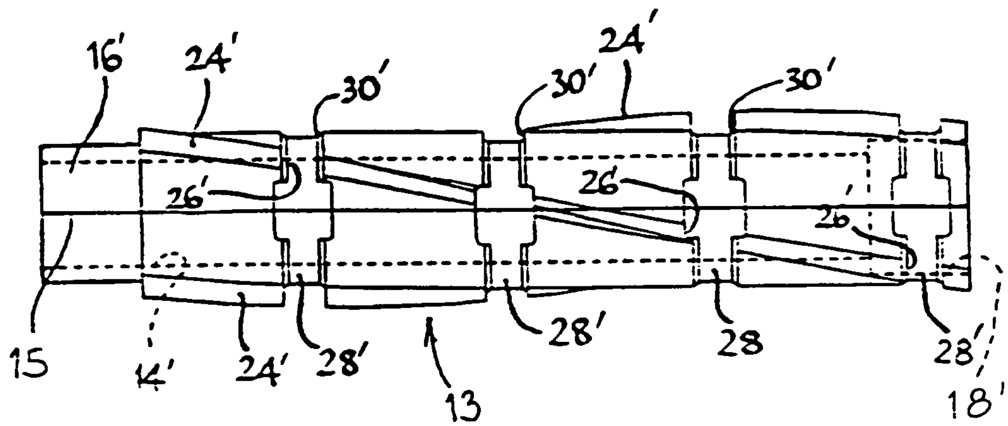

FIG. 10.

DESCRIPTION

PROTECTION OF UNDERWATER ELONGATE MEMBERS

The present invention relates to the protection of underwater pipes, cables or other elongate members.

When water flows past an underwater pipe, cable or other elongate member of circular cross section, vortices are shed alternately from each side. The effect of these vortices is to induce fluctuating, across-flow forces on the structure. If the natural frequency of the structure is close to the shedding frequency of the vortex the member can be caused to vibrate with a large oscillation amplitude.

Such oscillations not only cause the pipe, cable or member to bend more than is desirable, but can also induce unwanted forces on a connector (either under water or above water) to which the pipe, cable or the like is secured. In extreme cases, the coupling between the pipe, cable or the like and the connector is damaged.

It is an object of the present invention to avoid or reduce these so-called "vortex induced vibrations".

In accordance with the present invention, an underwater cladding for an elongate member comprises one or more external projections to interrupt or reduce vortex induced vibrations.

By interrupting or reducing the vortex induced vibrations, the damage to the pipe, cable or the like and any fitting to which it is connected, can be

greatly reduced or even avoided.

Preferably the or each projection is substantially elongate. The or each projection should also preferably be sharp-edged and preferably triangular in cross-section.

The height of the or each projection is preferably from 0.1 to 0.15 times the external diameter of the cladding.

Preferably, the or each projection is substantially helical. If so, the pitch is preferably from 4 to 6 times, and more preferably approximately 5 times, the external diameter of the cladding.

Preferably, there are a plurality of external projections, e.g. three, and they are advantageously evenly spaced around the periphery of the cladding.

The projections may be resiliently compressible or deformable. This allows the clad pipe to be fed through conventional pipe-laying apparatus without fouling. The projections may be hollow or may be solid.

Alternatively, the projections could be substantially undeformable.

The cladding may be in the form of a series of substantially tubular or part-tubular preformed sections which, when assembled, form a longitudinal through passage which is shaped and dimensioned to receive a pipe or other elongate member to be clad.

Alternatively, the cladding may comprise one or more generally planar mats each having one or more projections on its external surface, the mat, in use, being wrapped around a pipe or other elongate member to be clad. The or

each projection preferably forms a helical projection when the mat is wrapped around the elongate member.

The mat may be substantially rectangular or of substantially parallelogram in shape prior to being wrapped around the elongate member. In the latter case, an elongate external projection may be located along one lateral edge of the mat.

By way of example only, specific embodiments of the present invention will now be described, with reference to the accompanying drawings, in which:-

Fig. 1 is a side elevation of a section of pipe fitted with an embodiment of cladding in accordance with the present invention ;

Fig. 2 is a cross-section of the clad pipe shown in Fig. 1, looking in the direction of arrows II - II;

Fig. 3 is a plan view to a larger scale of a section of the cladding shown in Fig. 1;

Fig. 4 is a plan view of the inner surface of one of the cladding sections illustrated in Fig. 3;

Fig. 5 is a view of a section of pipe fitted with a second embodiment of cladding in accordance with the present invention;

Fig. 6 is a cross-section through the clad pipe of Fig. 5, looking in the direction of VI - VI;

Fig. 7 is a plan view of the exterior surface of one of the components of the cladding illustrated in Fig. 5, prior to application of the cladding;

Fig. 8 is a cross-section through the cladding portion of Fig. 7, looking in the direction of arrows VIII - VIII;

Fig. 9 is a plan view of the exterior surface of one of the components of a third embodiment of pipe cladding in accordance with the present invention prior to application of the cladding;

Fig. 10 is a cross-section through the cladding portion of Fig. 9, looking in the direction of arrows X-X; and

Fig. 10 is a side view of a fourth embodiment of cladding in accordance with the present invention.

Referring firstly to Figs. 1 to 4, a pipe 10 is clad in a protective ducting 12. The ducting is generally as described in GB-A-2260590 and comprises a tubular flexible, impervious, polyurethane casing comprising a plurality of identical, releasably engaged, semi-tubular sections 12' which are arranged with respect to one another to provide a cylindrical passage 14 therethrough which is dimensioned and shaped to receive the pipe. In use longitudinally adjacent sections are secured to one another by fitting a reduced outer diameter end spigot portion 16 of one section into a complementarily-shaped, enlarged inner diameter end socket portion 18 of the adjacent section.

Each section 12' is provided with a series of small lugs 20 along one diametrically opposed edge 21 and a series of complementarily positioned and shaped recesses 22 in the other diametrically opposed edge 23. Diametrically-opposed sections are secured to one another by engaging the lugs 20 in the

corresponding recesses 22 in the abutting edge 23 of the diametrically-opposed section. Diametrically-opposed sections are also "staggered" by approximately half the length of a section to ensure that the vertical joints between two longitudinally adjacent sections are not aligned with the vertical joints between diametrically-opposed longitudinally adjacent sections.

Each section of ducting is also provided with three identical, part-helical strakes 24. As illustrated in Fig. 2, the strakes are angularly spaced by 120° at any cross-section through the strakes. The strakes on each section are arranged such that when the cladding is assembled from the plurality of cladding sections, the strakes thereby formed on the exterior of the cladding thus formed are substantially continuous, with the exception of regularly longitudinally-spaced slots 26 for receipt of securing bands 28 of metal or other material which are located in circumferential recesses 30 in the assembled ducting.

In use, the preformed sections 12' are located on the exterior of a section of pipe to be protected and are secured to each other around the pipe by means of the aforementioned projections 20 and recesses 22 and by means of the metal banding 28. The ducting thus formed comprises three helical, substantially continuous (with the exception of the gaps 26 provided for receipt of the securing bands) strakes. As best seen in Fig. 2, the strakes are substantially triangular in cross-section and are sharp-edged. It has been found that the pitch of the strakes should be between four and six, and preferably approximately five, times the external diameter of the cladding and that the height of the strake

should be 0.1 to 0.15 times the external diameter of the cladding. There should also preferably be, as illustrated in the first embodiment, three helical strakes.

As can be seen in the enlarged portion of Fig. 2, the strakes are also hollow, having an elongate void 25 of substantially triangular cross-section passing therealong. This makes the strakes compressible and resiliently deformable and allows them to be deformed after installation of the cladding on a pipe after it passes, for example, through rollers. The deformable nature of the strakes also allows the pipe to be gripped more tightly after having been clad, e.g. to control its deployment. Alternatively, the strakes may be solid but may still be compressible and resiliently deformable or alternatively may be substantially rigid.

When a pipe is clad in this way and is submerged under water, the presence of the strakes prevents the formation of, or significantly reduces the intensity of, vortices and thereby eliminates or reduces vortex induced vibrations. This results in greater stability of the pipe and increases the useful life of the pipe and the connectors to which it is attached.

In the second embodiment illustrated in Figs. 5 to 8, the preformed semi-tubular sections of the first embodiment, whose inner surfaces are shaped to correspond to and receive the outer surface of the pipe to be protected, are replaced with a series of flexible, substantially planar, impervious, rectangular polyurethane mats 40 which are provided with a series of strakes 42 on their outer surface. The strakes are sharp-edged and are triangular in cross-section

and as for the first embodiment the strakes are hollow (although may be solid) to make them compressible and resiliently deformable. In contrast to the first embodiment, each mat is wrapped around the pipe to be protected and is secured in position by means of metal bands 44 which are seated in circumferential grooves defined by slots 46 in the strakes.

Adjacent mats are secured end to end and are aligned around the circumference of the pipe by means of three tongues 48 at one end of each of the mats, each of which is received in a respective groove 50 located in the other end of each of the mats. The strakes are inclined at about 32° to the longitudinal axis of the mat when flat so that when the mats are wrapped around the pipe to be clad and adjacent mats are secured together in position with the tongues 48 of the end of one mat received in the grooves 50 of the end of the adjacent mat the strakes on the assembled cladding thus formed comprise three helical, substantially continuous (except for the slots for receiving securing bands) strakes externally of the pipe. The dimensions of the strakes are identical to those in the first embodiment.

As for the first embodiment, the presence of the helical strakes (which are angularly spaced apart by 120° at any cross-section through the strakes) prevents the formation of, or significantly reduces the intensity of, vortex induced vibrations as a result of water flowing past the clad pipe.

One potential drawback with the second embodiment is that, in certain circumstances, when the mats are wrapped around a pipe the flat portions

between the strakes at side edges of the mats can tend to ruck up and not lie flat.

In an attempt to overcome this problem, in the third embodiment, shown in Figs. 9 and 10, the rectangular polyurethane mats are replaced with mats 54 which are of identical material but which are a parallelogram in plan prior to installation. Moreover, one of the strakes 56 is located adjacent to one of the lateral edges 58 of the mat so that as the mat is wrapped around a pipe the opposite edge 60 of the mat (and of adjacent mats) can be tucked under the strake 56 so that, with the exception of gaps 62 to allow the fixing of securing bands as for the second embodiment, a strake 56 is located along each joint at the side edges, which reduces the likelihood of the edges of the mat from rucking up.

The mat 54 of Figs. 9 and 10 is provided with three strakes 56, 64, 66 which are parallel to one another prior to installation. The strakes themselves are of the same dimensions as those of the second embodiment and are also similarly hollow (although may be solid), as best seen in Fig. 10.

As for the second embodiment, adjacent mats 54 are secured end to end and are wrapped around the circumference of a pipe, by means of three tongues 68 at one end of each mat, each of which is received in a respective groove 70 located in the other end of each mat (the centre line CL of the pipe is shown in Fig. 9). As mentioned above, as the mats are wrapped around the pipe the free edge 60 of each mat is tucked under the other edge beneath the lateral strake 54 of the mat and/or of an adjacent mat. This is facilitated by tapering the mat

towards the free edge 60 (as shown at 72 in Figs. 9 and 10) and providing a complementarily shaped undercut 74 on the inner surface of the mat adjacent the opposite edge, beneath the lateral strake 56. The mats are then secured in position using metal bands, as for the second embodiment.

A variation of the first embodiment is shown in Fig. 10. The cladding in this embodiment is a generally tubular (rather than semi-tubular), flexible, impervious, polyurethane casing 13 having an elongate cylindrical through passage 14' which is dimensioned and shaped to receive a pipe, as in the first embodiment. However, the casing is tubular and is provided with a single, longitudinally extending slit 15 extending through the wall of the casing along the whole of its length. Thus, the casing may be fitted onto a pipe by pulling apart the portions of the casing on either side of the slit 15 and manoeuvring the casing onto the pipe. The material forming the casing has sufficient resilience to allow this fitting procedure to take place. A plurality of casings is usually fitted, end-to-end, to cover the desired length of pipe.

The ends of the casing may be flat, whereby adjacent casings simply abut one another face-to-face, or, as illustrated in Fig. 10, the two ends of the casing may be formed into a spigot portion 16' and a socket portion 18' respectively, whereby the spigot portion 16' of one casing can be received in the socket portion 18' of an adjacent casing.

Similar to the first embodiment, each casing is provided with three helical strakes 24' which are angularly spaced by 120° at any cross-section.

The strakes are also provided with a plurality of regularly longitudinally-spaced slots 26' for receipt of securing bands 28 of metal or other material which are located in circumferential recesses 30' in the casing, for holding the slot 15 of the casing tightly shut. The construction and size of the strakes 24' are identical to the first embodiment.

The invention is not restricted to the details of the foregoing embodiments. For example, with reference to the first embodiment the strakes may initially be omitted from cladding and instead the cladding may be provided with a plurality of helically-extending grooves which are adapted to receive strake sections secured therein at a later date in order to form a cladding having a plurality of external strakes, in a "retrofit" manner.

Furthermore, although the strakes have been described as being compressible and resiliently deformable (whether hollow or solid) the strakes may instead be resistant to substantial deformable deformation, if desired.

Although the specific embodiments have been described with reference to the cladding of pipes, the invention is not restricted thereto but is equally applicable to underwater cables or other elongate members.

CLAIMS

1. An underwater pipe cladding comprising an external projection to interrupt or reduce vortex induced vibrations.

2. An underwater pipe cladding as claimed in claim 1, comprising an elongate external projection.

3. An underwater pipe cladding as claimed in claim 2, wherein the external projection is sharp-edged.

4. An underwater pipe cladding as claimed in claim 2 or claim 3, wherein the external projection is triangular in cross-section.

5. An underwater pipe cladding as claimed in any of claims 2 to 4, wherein the height of the external projections is from 0.1 to 0.12 times the diameter of the pipe to be clad.

6. An underwater pipe cladding as claimed in any of claims 2 to 5, comprising a substantially helical projection.

7. An underwater pipe cladding as claimed in claim 6, wherein the pitch of the substantially helical projection is from 4 to 6 times the diameter of the pipe to be clad.

8. An underwater pipe cladding as claimed in claim 7, wherein the pitch of the substantially helical projection is approximately five times the diameter of the pipe to be clad.

9. An underwater pipe cladding as claimed in any of the preceding claims, comprising a plurality of external projections.

10. An underwater pipe cladding as claimed in claim 9, comprising three projections.

11. An underwater pipe cladding as claimed in claim 9 or claim 10, wherein the projections are substantially evenly spaced around the periphery of the cladding.

12. An underwater pipe cladding as claimed in any of the preceding claims, wherein the or each external projection is resiliently deformable or compressible.

13. An underwater pipe cladding as claimed in any of the preceding claims, wherein the or each external projection is hollow.

14. An underwater pipe cladding as claimed in any of the preceding claims, comprising a plurality of preformed substantially tubular or part-tubular sections which, when assembled, form a longitudinal through passage which is shaped and dimensioned to receive a pipe to be clad.

15. An underwater pipe cladding as claimed in any of claims 1 to 13, comprising a flexible, generally planar mat having one or more projections on its external surface, the mat, in use, being wrapped around a pipe to be clad.

16. An underwater pipe cladding as claimed in claim 15, wherein the or each projection forms a helical projection when the mat is wrapped around a pipe.

17. An underwater pipe cladding as claimed in claim 15 or claim 16, comprising a plurality of mats.

18. An underwater pipe cladding as claimed in any of claims 15 to 17, wherein the mat is substantially rectangular prior to being wrapped around the pipe.

19. An underwater pipe cladding as claimed in any of claims 15 to 17, wherein the mat has a substantially parallelogram shape prior to being wrapped around the pipe.

20. An underwater pipe cladding as claimed in claim 19, comprising an elongate external projection extending adjacent to and parallel to a lateral edge of the mat.

21. An underwater pipe cladding as claimed in any of claims 15 to 20, comprising a plurality of elongate projections on the external surface of the mat which are substantially parallel prior to the mat being wrapped around the pipe.

22. An underwater pipe cladding substantially as herein described, with reference to the accompanying drawings.

Application N :	GB 9905276.3	**Examiner:**	Dr Steve Chadwell
Claims searched:	1-21	**Date of search:**	7 July 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): E1F (FAC1); E1H (HCE, HCF, HGG); F2P (PC1, PC3, PC9, PC10, PC14); F2R (RD, RR, RZ)

Int Cl (Ed.6): E02D 5/60 5/64; E21B 17/00 17/01; F15D 1/00 1/10 1/12; F16L 57/00 58/00 58/02 58/10

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	GB 2315797 A	(CORROSION CONTROL INTER'L) see whole document	X: 1-3, 5-21 Y: 4
X	GB 2303898 A	(SHELL) see whole document, especially figures 1B and 3B	1,2,6,9,11, 14
Y	GB 2298016 A	(ZANUSSI) see figures 2 and 3	4
Y	GB 1279599	(CABLES DE LYON ALSACIENNE) see figure 1	4
Y	GB 1019885	(SMITH & SONS) see figure 7 in particular	4
X	WO 98/19018 A1	(N.I.C.C.) see whole document	1-3,6,9-12, 14-17,19-21

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.